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No. III.

Experiments relating to the Absorption of Air by Water.
By Dr. JOSEPH PRIESTLEY.

IN my attempts to ascertain the proportion between the phlogisticated and dephlogisticated air that constitutes the atmosphere, of which I gave an account in the fourth volume of the *Philosophical Transactions of Philadelphia*, I made one of my computations from the diminution of atmospherical air by a mixture of nitrous air, considering one-third of the quantity that disappeared to have been dephlogisticated air; and since by long standing this diminution proceeded much farther than at the first, I concluded that this farther diminution was occasioned by the same cause as the first, only operating more slowly, and consequently that there was in the atmosphere much more dephlogisticated air than had been supposed. Since that time, however, I have found that this second absorption has some different cause, though I have not been able to discover it; because if sufficient time be allowed, all kinds of air without distinction will be wholly absorbed by the water with which they are confined.

As this observation was made in consequence of resumming the experiments of which an account was given before, viz. on mixtures of nitrous and common air, I shall first recite those which were made with this mixture. In the beginning of May 1798 I set by a mixture of this kind, then occupying the space of 1.25, and observed that, without agitation, the diminution kept proceeding (though it was sometimes stationary) till on the 18th of October, I examined it, and found it to be

0.34, which was considerably less than I had observed before. Replacing it in the same vessel, I found that on the 30th of Nov. it was 0.27; Dec. 2d it was 0.22; Jan. 1st it was 0.11; Feb. 12th it was 0.09; Feb. 24th it was 0.06, and on April 3d it was completely absorbed.

Observing this progressive diminution, I made other mixtures of the same kind, and occasionally examined them, but I do not think it necessary to recite more than two more of the results.

Equal quantities of common and nitrous air put together Oct. 5th was on Dec. 2d reduced from 1.25 to 0.83; Jan. 1st it was 0.52; Feb. 21st 0.31; March 31st 0.25; April 3d 0.21; May 25th 0.22; July 1st 0.11; and on July 24th it was wholly absorbed. Another mixture of the same kind made Dec. 11th was vanished July 1st.

A mixture of equal quantities of common and inflammable air fired together Dec. 13th, and then occupying the space of 1.29, was wholly vanished July 19th.

That this diminution and absorption depended on the *water* by which it was confined, was evident from a mixture of equal parts of common and nitrous air being kept without any change confined by mercury from October to the April following.

Being now fully satisfied that this diminution of air, and its final absorption, was wholly independent of the action of nitrous air, I exposed in the same manner all kinds of air that could be confined by water to the same influence; and I always found that, in more or less time, the whole of any quantity would be wholly absorbed, though a large surface of the water in which the vessels containing them were placed was exposed to the common atmosphere, and therefore had an opportunity of saturating itself with air, and of a purer kind than

than several of those that were in the jars. And this is the circumstance which makes the experiment of such difficult solution. I always, however, found that when common air was subjected to this experiment, the dephlogisticated part of it was absorbed in the first place. For whenever I examined the air it was always found to be more and more phlogisticated, till at last it was wholly so; and this was generally the case when about three-fourths of the quantity remained unabsorbed.

Ten ounce measures of common air exposed to rain water from the 28th of July to the 15th of August, in a glass jar about ten inches in diameter, were reduced to 7 ounce measures, completely phlogisticated, as was another quantity of 20 ounce measures, when it was reduced to 15.

In order to ascertain what kind of air would be most affected in these circumstances, I exposed equal quantities of them in the same manner on the 19th of Dec. and observed them all to be gradually diminished, till July 1st; when the dephlogisticated air was reduced to a very small bubble, and on July 6th the inflammable and common air, and an equal mixture of common and nitrous air, were all wholly vanished. Nitrous air was always absorbed sooner than any other, till it was reduced to the state of phlogisticated air, which, if the surface exposed to the action of the water was large, was soon effected.

Thinking that the nearer the air on which this experiment was made was to the common atmosphere, the sooner this absorption would be effected, and that the farther it was from it the more time would be requisite for it, I put a measure of common air into a glass tube 5 feet in length, placed in a trough of water 18 inches deep, so that there were $6\frac{1}{2}$ feet from the confined air to the atmosphere. But being left in this situation from June 5th to July 28th, it was reduced to 0.8, completely

pletely phlogisticated; so that this long space of water had been little or no obstruction to this process.

On the 21st of Jan. I set by two quantities of common air, each one measure, in two similar glass jars, one plunged several inches under the water, and the other placed on the shelf in the same trough, thinking that a difference in the *pressure* to which they were subjected might make some difference in the absorption; and till the 26th of March that which was on the shelf was more diminished than that which was under the water, and therefore more compressed, but on that day they were exactly equal, viz. 0.55. After this that which was sunk in the water was more diminished than the other. On the 30th of April, that which was sunk was 0.48, and that on the shelf 0.59; but on the 1st of July, when I put an end to the experiment, the changes were reversed again; for that which was sunk was 0.17, and that on the shelf 0.08.

I found, however, that dilatation by an air-pump prevented the absorption, and compression by a condensing machine rather promoted it. To determine this I subjected one measure of common air to the pressure of about two atmospheres a month, in which time I kept another equal measure dilated about six times, and another in a similar vessel without dilatation or compression. This was then found to occupy the space of 0.85, the compressed air 0.76, and that which had been dilated had undergone no change at all.

I repeated this experiment on nitrous air from the 15th to the 28th of March, when the compressed air occupied the space of 0.47, the dilated was 0.91, and that which had been neither compressed nor dilated was 0.54. They had all lost their power of affecting common air nearly in the proportion of their diminution.

The

The last state of all these kinds of air was phlogisticated, that of inflammable air as well as the rest; and some idea of its gradual approach to this state may be formed from the following observations.

Five ounce measures of inflammable air were reduced from Aug. 19th to Sept. 5th to $1\frac{3}{4}$, barely inflammable. In the same time 2 ounce measures were reduced to 0.35, wholly phlogisticated; and from the same date to Nov. 9th, 3 ounce measures were reduced to $\frac{1}{2}$ an ounce measure, wholly phlogisticated.

Having formerly found air much changed by agitation in water, I now repeated these experiments with this view, and observed that the absorption went on rapidly to a certain point, but that the agitation impeded the total absorption, and when the water was warm the quantity was in some cases increased. But unless the jar in which I agitated the air stood in an open trough, a large surface of which was exposed to the atmosphere, the effect was inconsiderable.

After agitating one measure of common air ten minutes it was reduced to 0.36. After five minutes more it was 0.12, but after another five minutes it was 0.16; and though the air was much phlogisticated, it was never wholly so, being never worse than of the standard of 1.85, when two measures were reduced to one.

When one half of any quantity of inflammable air was absorbed in this process, it was wholly phlogisticated, though the air given out by the water in which it was agitated was of the standard of common air.

After agitating 2 measures of inflammable air, in water which contained air of the standard of 1.6, till it was reduced to less than one measure, I found it wholly phlogisticated. The agitation was continued an hour. Measuring after every five minutes, I observed the quan-

tity to be as follows: 1.66; 1.43; 1.25; 1.15; 1.05 and .99.

Having agitated 2 measures of inflammable air in distilled water an hour, I observed that, after being diminished, it was increased in bulk, and after some time it occupied the same space as at first. Being then examined, it was not at all inflammable, but had no fixed air in it, and it was of the standard of 1.13, when the air in the water was 1.01.

I agitated 5 measures of inflammable air in a trough of cold water fifteen minutes, when it was reduced to 2 measures, then in warm water, when it began to increase. After agitating it 20 minutes in this warm water, it was 5 measures; and being then examined it was not at all inflammable, and of the standard of 1.37. The air from the water was common air.

After agitating the same quantity of inflammable air the same time in cold water it was diminished to 3 measures, without any appearance of increase. There was then nothing inflammable in it, and it was of the standard of 1.37.

Dephlogificated air was soon reduced by this process to a much lower standard. After agitating 3 measures of this air, of the standard of 0.05 with 2 equal measures of nitrous air, the quantity was 1.66 of the standard of 1.17. Three measures of this air after five minutes agitation was 1.21. After five minutes more it was 0.96, and being then examined, it was of the standard of 1.7 with equal measures of nitrous air.

After agitating a mixture of 2 measures of inflammable air and one of dephlogificated five minutes, it was reduced to 1.98; after five minutes more to 1.46, and after another five minutes to 1.7, when it extinguished a candle.

Agitation

Agitation had the same effect on old and fresh made nitrous air. When both of them were reduced from $3\frac{1}{2}$ measures to about 2, they diminished a measure of common air to 1.4. The agitation was continued ten minutes.